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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/774,417

02/10/2004

Yoshiki Nishibayashi

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McDermott, Will & Emery
600 13th Street, N.W.
Washington, DC 20005-3096

EXAMINER

OLSEN, ALLAN W

ART UNIT	PAPER NUMBER
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1763

MAIL DATE	DELIVERY MODE
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08/31/2007

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/774,417	NISHIBAYASHI ET AL.	
	Examiner	Art Unit	
	Allan Olsen	1763	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 May 2007 and 31 May 2007.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3,4 and 12-18 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3,4 and 12-18 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 04 August 2004 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☒ Certified copies of the priority documents have been received in Application No. 09/995,854.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION***Drawings***

The drawings are objected to because in the remarks filed May 2, 2007, applicant noted that the fourth and fifth columns of Figure 10, which respectively represent the total atom percent of carbon and the total atom percent of fluorine, should reflect the 1:4 carbon to fluorine ratio of CF₄. This ratio is reflected in each row except for: comparative example 1, example 1 and comparative example 2. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1, 3, 4 and 12-18 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. As outlined below, various claims contain subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention.

Regarding claims 1, 3, 4 and 12-16, independent claims 1 and 12 each recite a power level of less than 1.0 W/cm^2 . While the specification includes two examples that use a power level of less than 1.0 W/cm^2 , there is no general disclosure pertaining to the entire range of less than 1.0 W/cm^2 . Furthermore, Examples 1 and 7 do not contain nitrogen. Applicant's remarks of May 02, 2007, state: "...none of cited art discloses etching diamond at a power of less than 1.0 W/cm^2 using a mixed gas comprising the elements oxygen, fluorine, and nitrogen." The examiner notes that applicant does not disclose etching diamond at a power of less than 1.0 W/cm^2 using a mixed gas comprising the elements oxygen, fluorine, and nitrogen.

Regarding claims 1, 3, 4, 13, 16, 17 and 18, claims 1, 13, 17 and 18 each recite a fluorine atom concentration within the range of 0.04% to 6%. These values correspond, respectively, to Example 6 and Example 1, as shown in Figure 10. These examples represent an embodiment that does not include nitrogen in the mixed gas.

Art Unit: 1763

However, the claims require the mixed gas to contain nitrogen. Specifically, claim 17 requires a nitrogen content of between 2.5% and 40% while claims 1 and 18 are directed toward methods wherein the amount of nitrogen is such that the intensity ratio A/B of said mixture reaches or maintains a particular threshold.

Furthermore, Figure 6 and the associated description is the only disclosure that pertains to a mixed gas that comprising carbon, fluorine, oxygen and nitrogen. Figure 6 pertains to a mixed gas of 1% CF₄ in O₂ and N₂. This is the sole disclosure with respect to a mixed gas comprising carbon, fluorine, oxygen and nitrogen. When a gas of 1% CF₄ in O₂ mixed with N₂ contains between 2.5% and 40% nitrogen, as is required by claims 16 and 17, the fluorine atom concentration ranges from a maximum of 0.02% down to 0.008%. The fluorine atom concentration range in this sole disclosure pertaining to a carbon, fluorine, nitrogen and oxygen mixed gas differs significantly from the claimed range of 0.04% to 6%.

Regarding the limitation that requires the A/B intensity ratio of said mixture to be greater than the intensity ratio A/B of pure oxygen, where A is the intensity of an emission peak caused by atomic oxygen and B is the intensity of an emission peak caused by molecular oxygen. The examiner notes the following puzzling aspects of the disclosure. The upper line of Figure 5 indicates the emission spectrum from a 100% O₂ plasma yields an A/B ratio of 2.5 while emission data from a mixed gas of 1% CF₄ in O₂ yields an A/B ratio of 2.8. Curiously, Figure 6, indicates a 100% O₂ plasma yields an A/B ratio of 2.1 while a mixed gas of 1% CF₄ in O₂ yields an A/B ratio of 2.8

Art Unit: 1763

	A/B ratio from 100% O ₂	A/B ratio from 1% CF ₄ in O ₂
Figure 5	2.5	2.8
Figure 6	2.1	2.2

Figure 6 indicates that a mixed gas of 1% CF₄ in O₂ and nitrogen can have a nitrogen content from 0% to ~60%, and still have an A/B ratio that is greater than that obtained from a pure O₂ plasma. However, the maximum A/B ratio in figure 6 is less than 2.5 but Figure 5 shows an A/B ratio for a 100% O₂ plasma of 2.5. Using this A/B for a pure O₂ plasma suggests that no amount of nitrogen, when added to a mixed gas of 1% CF₄ in O₂, would yield an A/B ratio that exceeds that which is obtained from the emission spectrum of a pure oxygen plasma.

Among the possible explanations for this is that intensity ratio A/B in figure 6 was obtained using different wavelengths than those used to determine the A/B ratio in figure 5. However, it is not evident from figure 4, what possible combination of wavelengths could give rise to the data of figure 6. Still other possible explanations could be put forth. However, such should not be left to conjecture because doing so imposes the burden of undue experimentation upon the skilled artisan.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Art Unit: 1763

Claims 1, 3, 4 and 12-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over the paper by Shiomi, "High-Rate Reactive Ion Etching of Diamond and Fabrication of Porous Diamond for Field-Emission Cathode", in New Diamond, Vol. 13, No 4. pp 28-29, in view of US Patent 6,261,726 issued to Brooks et al. and further in view of US Patent 6,013,191 issued to Nasser-Faili et al. (hereinafter, Shiomi, Brooks and Nasser-Faili, respectively).

Shiomi teaches the reactive ion etching of a masked diamond surface. Shiomi teaches the mask comprises aluminum (page 2, line 17 of translation). Shiomi teaches that diamond is etched by a plasma of 100% O₂. Shiomi teaches that the plasma may alternatively comprise NO₂ or N₂. Shiomi teaches that the angle of the sidewall can be controlled by adding CF₄ to the etchant. Shiomi teaches that vertical sidewalls can be obtained by adding a very small amount of CF₄. Shiomi teaches using a CF₄ concentration as low as 0.125% (page 5, line 2).

With respect to independent claims 1 and 12, Shiomi does not teach supplying less than 1.0 W/cm² of power to the RIE process. With respect to independent claims 17 and 18, Shiomi does not teach supplying at least 0.45 W/cm² of power to the RIE process. Shiomi does not teach using a both O₂ and N₂ in the plasma gas.

Brooks teaches etching diamond with a mixture of O₂ and N₂. See column 6, line 63.

Nasser-Faili teaches etching diamond within various types of plasma chambers and under a variety of process conditions. Nasser-Faili teaches using a power density of "about 1 W/cm²" which encompasses the claimed "less than 1.0 W/cm²" and the claimed "at least 0.45 W/cm²".

It would have been obvious to one skilled in the art to etch diamond with plasma comprising O₂ and N₂ and a fluorine-containing compound because Shiomi teaches using either O₂ or N₂ and "[i]t is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition which is to be used for the very same purpose."¹ Furthermore, because Shiomi teaches etching diamond with an O₂ plasma while Brooks teaches etching diamond with an O₂/N₂ plasma, a person having ordinary skill in the art would recognize an O₂ plasma and an O₂/N₂ plasma as being functionally equivalent with respect to the etching of diamond.

It would have been obvious to one skilled in the art to add fluorine to the O₂/N₂ mixture of Brooks because Shiomi teaches that the addition of fluorine allows one to gain control over the etching profile. Additionally, in view of Nasser-Faili's teaching, the skilled artisan would have reasonable expectation of success because Nasser-Faili demonstrates the etching of diamond with plasma comprising oxygen, nitrogen and a low fluorine content.

It would have been obvious to one skilled in the art to apply power with a power density of least 0.45 W/cm² because Nasser-Faili teaches that by supplying 1.5 W/cm² of power, one can obtain vertical structures similar to those obtained taught by Shiomi.

Regarding the newly added limitation that requires providing a sufficient amount of nitrogen to the gas mixture so that the ratio of the emission intensity of oxygen atoms to the emission intensity of molecular oxygen is greater than it would be in pure

¹ *In re Kerkhoven* 205 USPQ 1069 (CCPA 1980). Cites *In re Susi* 169 USPQ 423, 426 (CCPA 1971); *In*

Art Unit: 1763

O₂ plasma, the examiner notes the well-established principal that the ratio of atomic oxygen to molecular oxygen (O:O₂) increases when fluorine is added to an oxygen plasma (See, for example, IBM Technical Disclosure Bulletin NN8712128). As such, using the gas mixture made obvious by Shiomi, Brooks and Nasser-Faili one would expect the A/B emission ratio to be greater than that which would be obtained from a pure O₂ plasma.

Response to Arguments

Applicant's arguments filed May 2 and May 31, 2007 have been fully considered but they are not persuasive.

Regarding the rejections under 35 U.S.C 112, the examiner appreciates the point raised by applicant that it does not matter which particular set of wavelengths are selected when determining the A/B ratio. Additionally, the examiner appreciates the rationale that applicant cites for selecting wavelengths having large peaks (e.g., 777 nm for atomic oxygen and 558 nm for molecular oxygen). Nevertheless, the claims are still rejected under 35 USC 112 for the reasons stated on pages 3-5 of this Office action, for example, for incorporation new matter by reciting "less than 1.0 W/cm²".

Regarding applicant's remarks pertaining to the prior art rejections under 35 USC 103, applicant argues "none of cited art discloses etching diamond at a power of less than 1.0 W/cm² using a mixed gas comprising the elements oxygen, fluorine, and nitrogen". As a first point, the examiner again notes that applicant too fails to disclose

Art Unit: 1763

etching diamond at a power of less than 1.0 W/cm^2 while using a mixed gas comprising the elements oxygen, fluorine, and nitrogen. Secondly, Nasser-Faili's teaching to use a power density of about 1.0 W/cm^2 is considered to read upon the claimed "less than 1.0 W/cm^2 ".

Additionally, applicants argue they have discovered that the addition of nitrogen to a plasma gas containing oxygen and fluorine has the unexpected result of allowing a reduction in plasma power. This is not persuasive because the lowest power that is disclosed in the specification while still yielding good results is in an embodiment that does not include nitrogen.

With respect to claim 15, applicant argues that none of the cited prior art teach or suggest an angle of inclination of at least 78 degrees in a projection or depression of a diamond product. However, this argument is not persuasive when one looks at the transmission electron photomicrographs of Shiomi (figure 5) and Nasser-Faili (figure 1) both of which depict features having angles of inclination of at least 78 degrees.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not

Art Unit: 1763

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allan Olsen whose telephone number is 571-272-1441. The examiner can normally be reached on M, W and F: 1-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on 571-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

A handwritten signature in black ink, appearing to read "Allan Olsen", is written over a horizontal line.

Allan Olsen
Primary Examiner
Art Unit 1763